Applications of SAR Interferometry to Surface Deformation in Central and Southwest Asia

Eric Fielding
Jet Propulsion Laboratory, California Institute of Technology*
James Jackson
Department of Earth Sciences, University of Cambridge
Tim Wright
Department of Earth Sciences, University of Oxford
Barry Parsons
Department of Earth Sciences, University of Oxford
Christopher Talbot
Institute of Earth Sciences, University of Uppsala

Much of the mid-latitude belt of Asia is semi-arid or arid, providing generally good conditions for repeat-pass synthetic aperture radar (SAR) interferometry (IntSAR) measurement of surface deformation with C-band ERS and Envisat data. The primary limitation on ERS IntSAR in most of this area is the sparse data coverage due to the lack of ground receiving stations. Temporary station deployments in 1995-96 and 1998-99 allowed the acquisition of some valuable ERS imagery in central and southwest Asia.

The large surface deformation field that accompanies co-seismic fault slip is the easiest signal to detect with limited data. More localized non-tectonic deformation, such as subsidence due groundwater or petroleum withdrawal or salt flow, and the more gradual interseismic or post-seismic deformation fields are more difficult to distinguish from atmospheric variations and other error sources.

The Alpine-Himalayan Belt is one of the tectonically active zones on the earth overlaps the arid to semi-arid swath of Asia. While some parts of the zone are well instrumented with GPS or other ground-based measurements, other parts are logistically or politically inaccessible to detailed field studies so IntSAR is the best way to make geodetic measurements of the surface deformation. Several recent large (M>6) earthquakes, especially in Iran, show complex mechanisms of fault rupture, both in their seismic signatures and the IntSAR deformation maps.

One example is the 10 May 1997 Zirkuh earthquake (Mw=7.2) in east Iran that had 125 km of surface rupture mapped in the field, and a long, complex seismic signal. ERS IntSAR pairs, with time intervals from two to six years, include the co-seismic deformation. While a large part of the Zirkuh IntSAR signal can be explained by strike-slip motion on a near-vertical fault, there are substantial variations between fault segments. The fortunate overlap of ascending and descending ERS pairs in the southern part give two components of the surface deformation and require that the southern segment rupture must have a substantial dip-slip component. This is consistent with seismic modeling that fit late waveform arrivals with a thrust-mechanism sub-event.

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